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(दूसरा पुनरीक्षण)

Indian Standard

TEXTILES — YARN — DETERMINATION OF BREAKING LOAD AND ELONGATION AT BREAK OF SINGLE STRAND

(Second Revision)

First Reprint JULY 1996

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April 1991 **Price Group 3**

Physical Methods of Test Sectional Committee, TXD 1

FOREWORD

This Indian Standard (Second Revision) was adopted by Bureau of Indian Standards after the draft finalized by the Physical Methods of Tests Sectional Committee had been approved by the Textile Division Council.

This standard was first published in 1960 and subsequently revised in 1970, and covered only testing of single cotton yarn using constant-rate-of-traverse machine. The standard is being revised to cover the testing of all types of yarns (single, plied or cabled and made from cotton, wool, silk, jute, man-made fibres or their blends and also yarn removed from fabrics) using constant-rate-of traverse, constant-rate-of-loading and constant-rate-of-extension machines and also to align it with ISO 2062 : 1972 'Textiles — Yarn from packages — Method for determination of breaking load and elongation at the breaking load of single strands — (CRL, CRE and CRT testers)', as far as possible.

The single strand method gives a more accurate measure of strength and elongation and more information of the percentage variation in the material than does the skein method. On the other hand, the single strand method, while using less material, requires more of operator's time and is accordingly costly. The skein breaking load is always less than the sum of the breaking loads of the same number of single strands broken individually. Elongation is an indication of the ability of yarn to absorb energy. If it is too low, weaving becomes difficult or even impossible but low-elongation yarns or cords have greater dimensional stability and are desirable as reinforcement for plastic products, hoses, tyres, etc.

In reporting the result of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

TEXTILES — YARN — DETERMINATION OF BREAKING LOAD AND ELONGATION AT BREAK OF SINGLE STRAND

(*Second Revision*)

1 SCOPE

1.1 This standard prescribes method for determination of breaking load and elongation at break of yarn using constant-rate-of-traverse, constant-rate-of-loading and constant-rate-of-extension machines. Since for any fibre type breaking load is approximately proportional to the linear density, strands of different sizes are compared by converting the observed breaking load to breaking tenacity (centinewtons or millinewtons per tex).

1.1.1 The method prescribed in this standard is applicable to monofilaments and multifilaments other than tyre cords and industrial yarns, and spun yarns (single, plied or cabled) made from all kinds of textile fibres or their blends with the exception of yarns that stretch more than 5·0 percent when tension is increased from 0·5 to 1·0 g (5 to 10 mN) per unit linear density of the yarn in tex.

1.1.2 This standard is designed primarily for yarn in package form but can be used for single strands removed/extracted from a woven/knitted fabric.

1.1.3 This standard does not cover textured yarns and fancy yarns.

1.1.4 This test method offers two options with respect to moisture content of the specimens at the time of testing.

1.1.4.1 *Option 1* — Conditioning to moisture equilibrium in the standard atmosphere for testing textiles (*see* IS 6359 : 1971).

1.1.4.2 *Option 2* — Testing in wet condition. Tests on wet specimens are usually made only on yarns which show a less strength when wet or when exposed to high humidity, for example, yarns made from animal fibres and man-made fibres based on regenerated and modified cellulose. Wet tests are made on flax yarns to detect adulteration by failure to gain strength.

1.1.5 This method also offers three options for the physical confirmation of the specimen.

1.1.5.1 *Option A* — Straight (*see* Note 4).

1.1.5.2 *Option B* — Knotted (*see* Notes 1, 2 and 3).

1.1.5.3 *Option C* — Looped (*see* Notes 1 and 3).

NOTES

1 The reduction in strength due to the presence of a knot or loop is considered a measure of brittleness of yarn. If a textile yarn is looped or knotted, its tensile strength may reduce. This can arise when a yarn is bent to a small radius of curvature (as in sewing or knitting) or knotted (as in the manufacture of nets). In order to assess the importance of these effects, loop strength and knot strength are described.

2 The knot strength test as described in this standard is not intended to assess the efficiency of any given type of knot for joining together two separate lengths of yarns.

3 Elongation in a knot or loop test is not known to have any significance and is not usually recorded.

4 Unless otherwise indicated, 'single-strand strength' is assumed to refer to a straight, conditioned specimen (Option 1A).

2 REFERENCES

2.1 The following Indian Standard are necessary adjuncts to this standard:

IS No.	*Title*
570 : 1964	Methods for determination of universal count of jute yarn (*revised*)
681 : 1964	Methods for determination of universal count of woollen and worsted yarns
1070 : 1977	Water for general laboratory use (*second revision*)
1315 : 1977	Method for determination of linear density of yarns spun on cotton system (*first revision*)
3920 : 1985	Methods for sampling of cotton yarn for determination of physical characteristics (*first revision*)
6359 : 1971	Method for conditioning of textiles

3 PRINCIPLE

3.1 The specimen is gripped between two clamps of the tensile testing machine and continually increasing load is applied longitudinally by moving one of the clamps until the specimen ruptures. Values of the breaking load and elongation at break of the test specimen are read directly or from a chart attached.

4 TERMINOLOGY

4.0 For the purpose of this standard, the following definitions shall apply.

4.1 Elongation (or Extension) at Break

In a tensile test, the difference between the length of a stretched specimen at breaking load and its initial length usually expressed as percentage of the latter.

4.2 Elongation at Rupture

The elongation occurring at the final rupture of the specimen. The elongation at rupture is usually but not always, identical with the elongation at the breaking load.

4.3 Knot Breaking Load

The breaking load of a strand with a knot tied in the portion of the specimen between the clamps.

4.4 Loop Breaking Load

The breaking load of a specimen consisting of two lengths of yarn or monofilament from the same package looped together so that one length has both its ends in one clamp of the testing machine and the other length has both its ends in the other clamp.

4.5 Single-Strand Breaking Load

The breaking load of a single strand of yarn, monofilament or cord, not knotted or looped but running straight between the clamps of the testing machine.

5 SAMPLING

5.1 The sample shall be drawn according to the procedure given in the relevant material specification or as agreed to between the buyer and and seller.

NOTE — For sampling cotton yarns, IS 3920 : 1985 may be followed.

6 CONDITIONING OF TEST SPECIMENS

6.1 Option 1: Conditioned Specimens

6.1.1 Prior to test, the specimens shall be conditioned to moisture equilibrium in the standard atmosphere of 65 ± 2 percent relative humidity and 27 ± 2°C temperature (*see* IS 6359 : 1971).

6.1.2 When the test specimens have been exposed to standard atmosphere for at least as much time as given below in such a way as to expose as far as possible, all portions of the specimens to the atmosphere, they shall be deemed to have reached moisture equilibrium:

Equilibrium Moisture Regain Value of the Yarn at Standard Atmosphere	*Time*
percent	hours
Less than 4	6
From 4 to 10	12 to 24
Above 10	24 to 48

6.1.3 The test shall be carried out in standard atmosphere (*see* **6.1.1**).

6.2 Option 2: Wet Specimens

Reel a short skein from each of the packages forming the test sample. Clamp a group of specimens by both ends to prevent loss of twist and submerge them in distilled or demineralised water at room temperature until they are thoroughly soaked and sink under their own weight. The time of immersion must be sufficient to wet out the specimens thoroughly. The time period will be at least 2 minutes for regenerated cellulose yarn and at least 10 minutes for acetate. For yarns that do not readily wet with water, such as those treated with water repellent or water-resistant materials, add a 0·1 percent solution of a nonionic wetting agent to the water-bath. Do not use any agent that will affect the physical properties of the yarn appreciably. If a wetting agent has been used, the specimen must be thoroughly rinsed in distilled or demineralised water before conducting the test. When using Option 2B, tie the knots very loosely before wetting in order to save time and to avoid handling while transferring the specimens from container to the testing machine.

7 APPARATUS

7.1 Testing Machine

A single-strand tensile testing machine working on one of the following principles:

a) Constant-rate-of-traverse (CRT),

b) Constant-rate-of loading (CRL), and

c) Constant-rate-of-extension (CRE).

7.1.1 It may be noted that, in most cases the results obtained on one type of machine will differ from those obtained on another type and the three types of testing machines will not necessarily give the same results for any given yarn.

7.1.2 Breaking load decreases slightly as the time-to-break increases. The rate of change is approximately of the order of 5 to 10 percent decrease in the breaking load for a ten-fold increase in the time to break. It is assumed that by testing with a specified time-to-break, any difference between the results is reduced to a minimum.

7.1.3 The specimens shall break within 20 ± 3 seconds in the case of constant-rate-of loading and constant-rate-of-extension machines. In the case of constant-rate-of-traverse machines, the rate of traverse shall be 300 ± 15 mm/min and the load range of the machine shall be such that the observed value lies between 10 and 90 percent of the full scale load. The permissible error in the machine at any point in this range shall not exceed ±1 percent of the load.

7.1.4 A variable-speed drive, change gears or interchangeable weights are required to obtain a constant time-to-break of 20 ± 3 seconds. If the rate of operation is adjusted in steps, the steps should not be greater than 1·25 : 1·00.

7.1.5 The machines shall be provided with the following arrangements:

a) Two clamps to grip the specimen, provided with a mechanical or pneumatic device so constructed that through its means it is possible to secure a specimen firmly between the jaws of the clamps so that it does not slip during the test. Also, the edge of the surface of each jaw as well as the jaw lining shall be such that it would not cut or damage the specimen during testing.

When specimens cannot be satisfactorily held with unlined flat-faced jaws, then lined jaws or, if necessary, capstan, drum, bollard clamps or snubbing type jaws may be used.

With some yarns these devices may be necessary in order to reduce the clamping pressure required to prevent slippage; otherwise the clamping pressure will have to be so great that jaw breaks would be frequent.

NOTES

1 Flat-faced clamps are usually used with fine yarns and the snubbing type clamps with high strength yarns or coarse yarns and when specimens slip in the clamps or the number of breaks at or close to the jaws exceeds statistical expectation. To check slippage, make a mark on the specimen as close as possible to the back of each clamp, operate the machine to break the specimens and observed whether the marks have been pulled towards or between the jaw faces of either clamp.

2 For sewing threads or similar yarns, clamps described as follows may be used:

For yarns of linear density up to 320 tex, use an inverted screw type clamp (Fig. 1) or pulleys with locking vices (Fig. 2) or pins. For yarns of linear density of 320 tex or higher, clamps of vice type (Fig. 3) may be used. With these clamps, specimen length is not determined precisely and consequently measurements of extension are not accurate and therefore the results should not be compared with those obtained with unlined flat jaws.

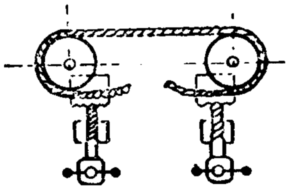

FIG. 1 INVERTED SCREW TYPE CLAMPS

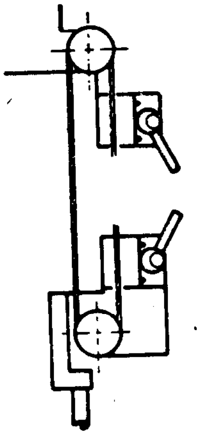

FIG. 2 PULLEYS WITH LOCKING VICES

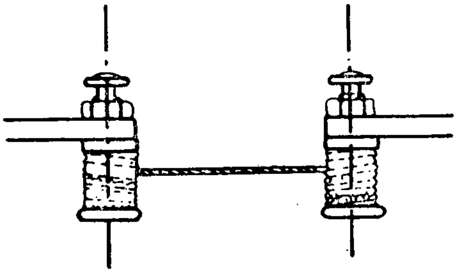

FIG. 3 CLAMPS OF VICE TYPE

b) Means for applying specified pre-tension to the specimen when clamped (the tension device may be a dead-weight, a spring, or an air-actuated mechanism). The pre-tension shall be as follows:

1) For conditioned specimens — 0·50 ± 0·05 cN/tex, and

2) For wet specimens — 0·25±0·03 cN/tex.

NOTE — This tension should not stretch the specimen more than 0·5 percent, otherwise a mutually acceptable lower tension should be applied.

c) Means for adjusting the distance between the clamps.

d) A scale or dial or autograph recording chart graduated so as to give load in cN or N and elongation in millimetres. The error of the indicated or recorded jaw separation shall not exceed 1 mm.

NOTE — Prior to test, care should be taken to ensure that the instrument is calibrated.

7.1.6 Automatic testing (self-loading and recording) machine may be used provided that it can be operated under specified conditions.

7.2 Container for Wetting Out Specimens.

7.3 Holder on Which the Yarn May be Supported Without Tension and Loss of Twist While in Water, for wet specimens only.

7.4 Distilled Water or Demineralized Water, *See* IS 1070 : 1977.

7.5 Nonionic Wetting Agent or Surfactant, for wet specimens only.

8 PROCEDURE

8.1 Set the clamps of the testing machine so that the distance between the nips of the clamps along the specimen axis (including any portion in contact with snubbing surfaces) is 500±2 mm (*see* Notes 1, 2 and 3). With the help of preliminary specimens, set the machine so that the specimen breaks within 20±3 seconds but if the machine is constant-rate-of-traverse type, set it at a rate of traverse of 300±15 mm/min. Take the yarn, discard a first few metres of it, and secure its one end in the jaws of one clamp in such a way that the twist does not change. Place the other end in the other clamp, apply the required pre-tension from this free end to remove any slack or kink without appreciable stretching and secure it in the jaws of the clamp.

NOTES

1 By mutual agreement, the nominal gauge length of 200±1 mm may be used, though under these conditions, results for breaking load are likely to be slightly higher than those obtained with a gauge length of 500 mm.

2 Traditionally the jute trade uses a test length of 610±2 mm for testing of jute yarns.

3 Traditionally the silk trade uses a test length of 100±2 mm for testing of silk yarns.

4 In case yarn removed from fabrics is to be tested, a test length of 200±2 mm shall be used.

5 Because of the difficulty of securing the same tension in all the filaments and slippage of the specimen in the clamps, erratic results are frequently obtained with zero twist multifilament yarns unless a small amount of twist is inserted before testing. A twist of 120±10 tpm is usually satisfactory. Twist a specimen about 225 mm longer than the gauge length to be tested.

8.2 Test the adequately conditioned specimens as described in **8.2.1** to **8.2.5** for different options.

8.2.1 *Option 1*: *Conditioned*

Test in the standard atmosphere for testing textiles as specified in **6.1.1**.

8.2.2 *Option 2*: *Wet*

Test the thoroughly soaked specimens in the normal machine set up or immersed in a tank fitted to the machine. Mount the specimens as described in **8.1** using a pre-tension of 0·25 ±0·03 cN/tex. Transfer the wet specimens directly from the water-bath to the testing machine and break the specimens at once, and in any case, within 2 minutes after removing them from the water-bath.

8.2.3 *Option A*: *Single-Strand Breaking Load*

Mount the specimen as directed in **8.1** using a pre-tension of 0·50±0·05 cN/tex. Operate the maching, carry the test to rupture and record the breaking load and elongation at break (*see* Note 1). If the specimen slips or breaks in the jaws or breaks within 5 mm from the edge of the jaws, the result shall be discarded and another test specimen taken in lieu thereof.

NOTES

1 In case of jute yarns where elongation tests are carried out separately, 10 tests for elongation may be sufficient.

2 Even if a test value is isolated on account of break near the jaw, the value shall be noted but not taken into account in calculations. If such breaks exceed 10 percent of the number of specimens tested, suitable corrective action on the machne should be taken.

3 Yarns made from blends or combinations of fibres may show elongation beyond the point of maximum load, particularly if one of the components is an elastomeric fibre. When the low elongation components of a yarn are broken, the load falls on the remaining fibres, which continue to elongate until they are broken. Breaking elongation is defined as that corresponding to the maximum load. If elongation continues after the maximum load has been passed, then elongation at rupture may be determined separately.

8.2.4 *Option B*: *Knot Breaking Load*

8.2.4.1 Place one end of the specimen in one clamp of the machine, tie a single overhand knot near the middle of the specimen. For a S-twisted yarn (*see* Note), a S-knot shall be used and for Z-twisted yarn a Z-knot shall be used (*see* Fig. 4 and 5). Place the other end in the second clamp and tighten the clamp.

NOTE — For plied and cabled yarns, the twist direction refers to the final twist.

8.2.4.2 Start the machine and observe and record the breaking load.

8.2.4.3 Repeat the procedure given in **8.2.4.1** and **8.2.4.2** until the required number of specimens have been broken.

8.2.5 *Option C*: *Loop Breaking Load*

8.2.5.1 Each specimen shall consist of two interlinked looped lengths of yarn taken from one package or end. Secure both ends of one piece in one clamp of the testing machine so that the length of the loop is about one half the gauge length.

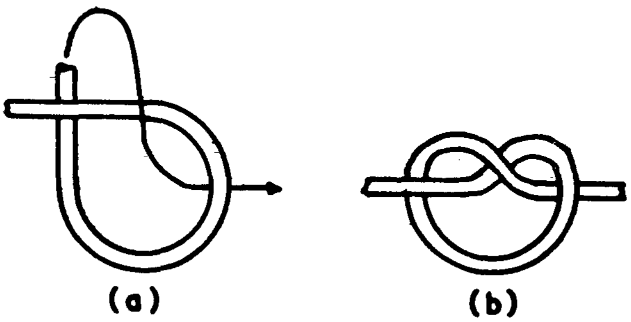

FIG. 4 Z-KNOT IN Z-TWIST YARN

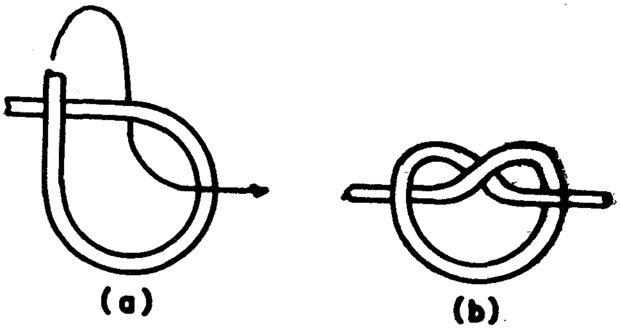

FIG. 5 S-KNOT IN S-TWIST YARN

Pass one end of the second piece through the loop formed by the first, place both ends of the second piece in the other clamp of the machine and close the clamp.

8.2.5.2 Start the machine and observe and record the breaking load.

8.2.5.3 Repeat the procedure given in **8.2.5.1** and **8.2.5.2** until the number of specimens have been broken.

9 CALCULATIONS

9.1 Breaking Load

Calculate the mean breaking load in newtons from all the observed values expressing it to three significant figures. Also calculate the coefficient of variation.

9.2 Elongation (or Extension) at Break (Option A only)

Calculate the mean elongation at break in percent from all the observed values expressing it to two significant figures. Also calculate the coefficient of variation.

9.3 Tenacity

Calculate the tenacity by the following formula:

Tenacity in cN/tex or mN/tex

$$= \frac{\text{(Mean breaking load in centinewtons or millinewtons)}}{\text{Mean linear density in tex}}$$

NOTE — The linear density of yarn or cord shall be determined from the same package in accordance with IS 570 : 1964, IS 681 : 1964 or IS 1315 : 1977 as the case may be.

10 REPORT

10.1 The test report shall include the following:

- a) Description of the material tested:
- b) Option used, for wet tests the technique used for wetting;
- c) Name of the instrument, capacity and load range operated;
- d) Mean time to break or rate of traverse;
- e) Test length;
- f) Type of jaw and jaw faces, if other than flat metal;
- g) Number of valid tests performed, number of tests rejected due to jaw breaks;
- h) Mean breaking load and coefficient of variation, if required;
- j) Mean elongation at break and coefficient of variation, if required; and
- k) Mean tenacity.

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